Intraspecific variation of copper tolerance of four endemic plant species from the Katangan Copperbelt (D. R. Congo)

Sylvain Boisson, Olivier Garin, Maxime Séleck, Soizig Le Stradic, Grégory Mahy
Natural metalliferous habitats

La Calamine, Wallonie, Belgium

Coyote Ridge, California, USA

Copperbelt, Katanga, D.R. Congo
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La Calamine, Wallonie, Belgium

Coyote Ridge, California, USA

Copperbelt, Katanga, D.R. Congo

Cd/Zn/Pb

Ni/Cr

Cu/Co
Natural metalliferous habitats

- Small size
- Extreme ecological conditions
- Ecologically isolated

→ Island nature
- Speciation processes

→ Endemic species
→ Specialized species

High distinctive plant species and community diversity
Katangan Copperbelt (D.R.Congo)
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More than 150 copper and cobalt outcrops (hills)
Katangan Copperbelt (D.R.Congo)

- 600 plant species
- 10% endemics
Katangan Copperbelt (D.R.Congo)
Katangan Copperbelt (D.R.Congo)

Unique plant communities
Séleck et al. 2013, Ilunga et al. 2013

Steppe
Steppic savanna
Mining activities

Impact on the katangan ecosystem

IUCN revision of copper endemics (Faucon, 2010)

CR 67 %  EN 3 %  VU 9 %  EX 9 %
Potential in rehabilitation strategies

600 species (55 endemics)
Metal tolerance capacities
(Hyper)accumulators
= phytogenetic resources
Introduction

Potential in rehabilitation strategies

600 species (55 endemics)
Metal tolerance capacities
(Hyper)accumulators
= phytogenetic resources
(Whiting et al. 2004)
Potential in rehabilitation strategies

600 species (55 endemics)
Metal tolerance capacities
(Hyper)accumulators
= phytogenetic resources

To conserve and use these species, we have to improve the knowledge about their ecology and their biology.
This study aims to...

Identify intraspecific copper tolerance of 4 endemic plant species from 3 sites of the katangan copperbelt in native conditions.
Studied species

*Crotalaria cobalticola*  
**Fabaceae**  
Annual  
Habitat: Steppes  
*Strict endemic*

*Diplolophium marthozianum*  
**Iridaceae**  
Perennial  
Habitat: Steppes  
*Broad endemic*

*Gladiolus ledoctei*  
**Iridaceae**  
Perennial  
Habitat: Steppes  
*Broad endemic*

*Triumfetta welwitschii*  
**Malavaceae**  
Perennial  
Habitat: Steppic savanna  
*Strict endemic*

<table>
<thead>
<tr>
<th>Family</th>
<th>Genus</th>
<th>Common Name</th>
<th>Status</th>
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<tbody>
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<td>Fabaceae</td>
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Seeds collection

Species populations:

3 populations between Tenke and Fungurume
One population/area
At the same year
Random sampling
Experimental design

BY SPECIES
Experimental design

BY SPECIES

3 POPULATIONS
T-M-F
Experimental design

**BY SPECIES**

3 POPULATIONS
T-M-F

3 COPPER CONCENTRATIONS IN SOIL

- 0 ppm
- 100 ppm
- 1000 ppm

Contaminated with CuSO$_4$·5H$_2$O + 0.2% compost
Experimental design

BY SPECIES

3 POPULATIONS T-M-F

X

3 COPPER CONCENTRATIONS IN SOIL

0 ppm
100 ppm
1000 ppm

Contaminated with CuSO₄·5H₂O + 0.2 % compost

X

10 repetitions with 5 seeds/bag
Measures, monitoring and analyses

• November 2013 – May 2014
• Before sowing, seedlots were weighed
• After February, 20 → 1 plant/bag
Measures, monitoring and analyses

- November 2013 – May 2014
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- Perennial species
  - Germination
  - Nb of leaves, height (cm)

- Annual species (C. cobalticola)
  - Germination
  - Nb of branches, height, root system length (cm)
  - Dry weight/modality (g)
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  - Dry weight/modality (g)

- Analyses: AV2 (R software)
Seed weight and germination

- No significant differences of seedlots weight between populations
- Mean germination rate

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No effect of copper concentrations on germination rates
Population effect on germination of *T. welwitschii*
**Growth of perennial species**

- **Population** effect on perennial species

---

**D. marthozianum**

- Number of leaves:
  - F: a
  - M: a
  - T: b

**T. welwitschii**

- Height (cm):
  - F: a
  - M: ab
  - T: b
Growth of perennial species

- **Copper concentration** effect on perennial species

**D. marthozianum**

**T. welwitschii**
Growth of perennial species

• Copper concentration effect on perennial species

*D. marthozianum*  
*T. welwitschii*
Growth of the annual species: *C. cobalticola*

- No population effect
- **Copper concentration** effect on perennial species
Growth of the annual species: *C. cobalticola*

- No population effect
- Copper concentration effect on perennial species

Lowest concentrations

Dry weight: $0.89 \pm 0.16 \text{ g}$
Growth of the annual species: *C. cobalticola*

- No population effect
- **Copper concentration** effect on perennial species

Lowest concentrations

Dry weight: $0.89 \pm 0.16 \text{ g}$

Highest concentrations

Dry weight: $1.72 \pm 0.09 \text{ g}$
To conclude

• According to species
  • Populations have an effect on growth AND/OR
  • Copper concentrations have an effect on growth
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• According to species
  • *Populations* have an effect on growth AND/OR
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• For *C. cobalticola*
  • Performance seems to be higher at 1000 ppm than 0 ppm Cu added → specialist
  • Few individuals had flowers and fruits → no statistical analyses
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• For G. ledoctei
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  • Performance seems to be higher at 1000 ppm than 0 ppm Cu added → specialist
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• For *G. ledoctei*
  • No significant effect of population and copper concentration
    BUT
  
  Resources allocated in bulbs ?
    !! plants stay until next year
In conservation and rehabilitation

• It is possible to regenerate endemic species from **steppic savanna** in **normal soils**
  • <> *C.cobalticola* (steppe)

• Population involve the growth of some perennial species
  • Prioritizing the conservation of performant populations in the first step
  • Then adding new populations to increase the diversity

• *C. cobalticola* present the highest tolerance level to copper → use in rehabilitation
Thank you for your attention
Seeds collection

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3 populations between Tenke and Fungurume
On each complex
At the same year
Random sampling